Abstract for STAIF-2000

Measurement of the Heat Capacity of He-II under a Heat Current near the Lambda Transition

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We present preliminary measurements of the heat capacity of superfluid helium-4 under an applied heat current near the lambda transition. The calorimeter is a standard cylindrical thermal conductivity cell with a 0.6 mm gap between two copper endplates. The sidewall is made of stainless steel. A heat current density in the range of 1 to 4 $\mu W/cm^2$ is applied through the helium sample while a pulse method is used to measure the heat capacity. Temperature changes are recorded with high-resolution thermometers (HRTs) located on the top and bottom endplates. Corrections are made to the readings of the HRTs to account for the Kapitza boundary resistance and the anomalous Kapitza boundary resistance. After the corrections, both the top and the bottom HRTs give the same heat capacity values. The heat capacity is found to be much larger than the prediction of recent theories[1,2]. We also plotted our data on a scaled plot to test the prediction of scaling by the theories[1,2]. The result and its interpretation will be presented.

The cell height was deliberately made to be thin to reduce the effects of gravity. Nonetheless, gravity is expected to have significant effects on the heat capacity data in the temperature range of our measurement. A space experiment would remove this unwanted gravity effect and allow the true physics to be examined. Moreover, in the absence of gravity, a deeper cell can be used allowing HRTs to be mounted on to the sidewall providing direct measurements of the helium temperature, unaffected by the anomalous Kapitza boundary resistance.

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2 R. Haussmann and V. Dohm, Phys. Rev. Lett., 77, 980 (1996).